Laboratoire de Mathématiques et Informatique pour la Compléxité et les Systèmes MICS

Présente

L'AVIS DE SOUTENANCE

De **M. Paolo Ballarini**
Maître de Conférence au Laboratoire MICS, soutiendra son mémoire en vue de l'obtention de l'Habilitation à Diriger des Recherches sur le thème :

"Contributions to formal modelling and analysis of stochastic models "

Le 6 juin 2023 à 13h00

A l'école CentraleSupélec, dans la salle sc.071 - Bâtiment Bouygues - en présentiel et en distanciel

Si vous souhaitez assister à la soutenance en distanciel, veuillez contacter en avance l'assistante du laboratoire pour obtenir le lien (fabienne.brosse@centralesupelec.fr)

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Membres du jury :

- Mr Eugenio CINQUEMANI (Rapporteur), Chargé de Recherche, INRIA Grenoble-Alpes, Grenoble (France)

- Mr Alain DENISE, Professeur, Laboratoire Recherche en Informatique (LRI), Université Paris Saclay (France)
- Mme Giuliana FRANCESCHINIS, Professeur, Directeur de Recheche, Dipartimento di Informatica, Università Piemonte Orientale, Alessandria (Italie)
- Mr Stefan HAAR , Directeur de Recheche, INRIA et Ecole Normale Superieur Paris Saclay (France)
- Mr Dave Pareker (Rapporteur), Professeur, Department of Computer Science, University of Oxford (Royaume-Uni)
- Mme Verena WOLF (Rapportrice), Professeur, Saarland University (Allemagne)

Résumé :

In this presentation I am going to overview a few contributions which revolve around the idea of employing hybrid automata to formally analyse a stochastic model. The talk will consist of three parts.

- An expressive statistical model checking framework.
The stochastic model checking problem is concerned with assessing the probability with which a discrete-state stochastic model, most commonly a continuous-time Markov chain, satisfy a given property normally expressed though a temporal logic language. The expressiveness of the property languages has been historically constrained by the by the need to rely on numerical approaches in the verification process. Those limitations have been relieved, to a degree, with the extension of numerical model checking to timed-automata property languages. In this contribution I will show that by moving to the simulation-based family of model checking and by introducing a property specification formalism based on hybrid automata one can get rid of those limitations and obtain a very expressive formalism suitable for sophisticated performance analysis of stochastic models.

- Parametric verification of stochastic models.
Complementary to the stochastic model checking problem is that of inference of a model's parameters driven by the satisfaction of a target temporal behaviour. The goal in this case is to identify the regions of the parameter's space that yield a positive probability to meet the target behaviour. By introducing the notion of satisfiability distance for basic time-bounded temporal modalities and by providing corresponding meter automata we were able to adapt Approximate Bayesian Computation, a

likelihood-free parameter-inference scheme, to solve the parametric stochastic model checking problem.

- Formal analysis of stochastic oscillators.

A stochastic oscillator can be thought of as a model that places most of the probability mass onto "noisy periodic paths" (of given average amplitude and average period). Differently from their continuous-deterministic counterpart, the characterisation of periodicity is not trivial as one has to account for the presence of stochastic noise all along a periodic trajectory. It has been shown that detection of sustained oscillation in a CTMC model boils down to a steady-state analysis problem of the CTMC combined with a noisy period detector deterministic finite automaton. As a follow up here we show that by adopting an hybrid automata formalism we obtain evolved periodicity detectors, that plugged within a stochastic simulation engine, allows one to assess sophisticated indicators such as the mean value and variance of the oscillation period as well as the oscillation amplitude. We further show how to adapt such hybrid automata so to assess the distance from a desired target oscillation period, resulting in an effective procedure that can be used for tuning stochastic oscillators.